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ABSTRACT

The problem-solving mode of teaching science implies change for teachers, administrators, state education departments, and other individuals charged with implementing educational innovation. This study provides a descriptive record and interpretation of the words and actions of an elementary school teacher beginning to learn about teaching science as problem solving rather than dispensing content information, and attempting to modify her teaching accordingly. Data collection spanned a period of one year and included classroom observations, interviews, and document analysis. Observations revealed that environmental factors such as administrative support and flexibility, availability of science materials, school philosophy, parental support, and teacher status strongly affected the teacher's effort to change. Personal or internal factors also influenced the teacher's classroom practice: background in science; ability to see interdisciplinary teaching possibilities; organizational ability; regard for individual student's ideas; need to maintain control over student activities and thinking; regard for other teachers' intelligence and experience; emphasis on success; need to "cover" a textbook; view of the relationship between science content and problem solving; and general openness to change. This study demonstrates that educators cannot control results merely by altering input. (MVL)

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THE PROBLEM WITH SUCCESS: CASE STUDY OF A TEACHER IN CHANGE

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THE PROBLEM WITH SUCCESS: CASE STUDY OF A TEACHER IN CHANGE

The mid-1960's and the early 1970's held great promise for elementary science education. Following the 1957 launching of Sputnik by the Russians, the now well-known activity/inquiry based, "alphabet soup" programs were developed: The Elementary Science Study (ESS), Science--A Process Approach (SAPA), and The Science Curriculum Improvement Study (SCIS).

Despite the fact that research demonstrated there were modest positive gains for students in these activity-based science programs compared with those in traditional programs (Bredderman, 1982), none was ever permanently adopted by more than 25 percent of the schools (Stake & Easley, 1978; Kyle, Shymansky, & Alport, 1982). Reasons given for the failure of these programs to be more widely adopted included the fact that the materials were either too expensive or too difficult to secure and maintain, and the activities required too much preparation time in an already busy school day (Stake & Easley, 1978; Shymansky, Kyle & Alport, 1982). Additionally, Connelly and Elbaz (1980), in speaking about the impossibility of excluding teachers from curriculum development in general, cited futile attempts to package teacher-proof materials as another reason for the lack of success of such programs.

In response to these acknowledged failures and with the intention of improving the quality of elementary science education, the New York State Education Department produced a new Elementary Science Syllabus and developed plans for a state-wide mentoring system to provide the long-term support deemed necessary for successful implementation of the syllabus. The focus of this document is problem solving, therein defined as "the ability to identify and solve science-related problems by applying appropriate skills systematically in ways that demonstrate positive science attitudes and an accurate understanding of science principles" (1985, p. 6).

This recommended problem solving mode of teaching elementary science implies change for teachers, administrators, state education departments, boards of education, and other individuals charged with implementing educational policy in general. Lighthall (1973) speaks of educational change as a process of coming to grips with the multiple realities of people who are the main participants in implementing change. This concept of multiple realities refers not only to individual differences among people, but also to the fact that each person experiencing change feels within herself some ambivalence and uncertainty as the awareness of multiple personal meanings grows. To add to the complexity, educational change is not a single entity. The change affects all three

dimensions that Fullan (1982) cites: the possible use of new or revised materials, the possible use of new teaching approaches, and the possible alteration of beliefs.

Because I wanted to investigate the subjective experience of a teacher making the transition from a traditional textbook, content-oriented approach to the teaching of science in a problem solving manner, a qualitative study was conducted. The choice was "predicated upon the assumption that an 'inner understanding' enables the comprehension of human behavior in greater depth than is possible from the study of surface behavior, from paper and pencil tests and from standardized interviews" (Rist, 1979, p.17).

DESIGN AND PROCEDURES

The study focuses upon a sixth-grade elementary school teacher, Jean, beginning to learn about the teaching of problem solving science and then attempting to modify her teaching accordingly. Jean is an energetic 48 year-old who teaches in a school which serves just under 1000 students and which is located in a very large, progressive, middle-class district. She has worked in the district for 20 years and is highly regarded by administrators, colleagues, parents, and children. Her students, well above average in scholastic ability, come from homes where education is given a high priority. These

students have been involved in an optional learning center program since fourth grade and are used to working in a variety of ways: independently, in small groups, and in whole class activities.

The program, initiated in response to the recognized socialization difficulties experienced by students who had participated in the previous acceleration program, was alternatively designed as an enrichment program. Highly individualized, the program seeks to encourage students to assume responsibility for completing activities that will help them to become independent learners. Students are selected for the Learning Center only after parents: 1) are informed about the non-traditional arrangement of classroom space into study centers, independent work areas and open spaces for whole class or small group activities; 2) understand that their children will "contract" with the teachers to complete the specific learning activities mutually selected as best suited for accomplishing a desired objective; and 3) agree with the teacher that their child should do well in this environment.

Before assuming his current administrative role, the school principal began the Learning Center Program and served very successfully as teacher/director for the first 13 years of its existence. Clearly an indication of the professional esteem he holds for Jean, he personally selected her to replace

him. Her dedication and enthusiasm for the program have contributed to its ongoing success; presently the option is open to all fourth, fifth, and sixth grade students and it is the choice for approximately half the students in these grades.

Jean admits to having always loved science and told me that during her days as an undergraduate student she had "taken every available elective in biology." This clearly affords her more background in science content than most elementary teachers have had and thus has contributed to her past confidence in teaching the subject. Her present willingness, as she puts it, to "branch out" and "let things be [more] relaxed" can also be attributed to this background.

The "not enough time" issue felt by many elementary teachers seems to be handled more positively by her than by most of the others; I observed many indications that she has a good sense of subjects overlapping. Reading is no longer taught as such by her because she feels that her students' skills in that area are adequate. Instead she uses the time that would normally be alloted for instruction from a basal reader to cover more content via reading. Writing too is frequently linked to science; for example, she challenged her students to write diary entries from the perspectives of animals of their choice. The required health program includes a great deal of coverage on the human body. At a curriculum

planning meeting with Phil, the district science coordinator, Jean seemed to feel confident enough to disagree with him and to take some initiative by insisting that material in the sixth grade science text "really is covered in the health textbook which the teachers love and use." Finally, in elaborating for me the importance (in order to save time) of interdisciplinary teaching, she referred to a specific page in the science text which dealt with map reading skills. "That's social studies," she commented. "No question about it."

Data Collection

Data was collected via observation, interview, and document analysis over the course of an entire year. Initial observations were made of Jean during seven full-day problem solving workshops which I conducted. Observations were recorded for brief entries during the workshops and for more detailed and reflective recordings during breaks and after the workshops ended each day. Upon the termination of the workshops, I observed Jean formally during a six week period in her own classroom.

Prior to classroom observations, I spoke informally with Jean. Since I had been her instructor, I deemed it important that she not view my presence in her classroom as a way for me to evaluate how well she had learned my lessons. Rather, I tried to communicate my desire to understand what it meant for

her to teach science within her own setting so that I might begin to comprehend her subjective experience of this imposed change. Following each classroom observation, I interviewed her.

Rist (1982) claims that "in the broadest sense, to conduct a good interview is to hold an interesting conversation....Ideas and perceptions are exchanged, information is shared, and participants come to know more about each other in the process" (p. 443). The informal nature of these interviews allowed them to be uniquely personal and provided me with an opportunity to focus on Jean's concerns. Detailed notes were taken both during and immediately after the interviews.

Documents examined for this study included plan books, curriculum guides, text books, other written resource material, bulletin boards, statements of school philosophy, samples of student work, and teacher memorandums. These were used in juxtaposition with observation and interview data. Observations enabled me to concentrate on Jean actively making meaning in her present context; document analysis provided an opportunity to focus on the past insofar as it influenced the present. Finally, interviews allowed for a further exploration of the present in the light of the past and future (Peshkin,

1982). Combined, the three data sources enabled me to probe the subjective meaning of Jean's experience.

Data Analysis and Interpretation

For this study the focusing questions, derived from my previous experience as a science teacher, New York State trained mentor, and workshop leader for elementary school teachers, were: Is it necessary for teachers to be reflective problem solvers themselves before being able to teach science in a problem solving manner? How do teachers come to "get" problem solving and how is the "getting it" manifested or distorted? What are the factors that either facilitate or inhibit the transition of teachers from a traditional textbook, content oriented approach, or from an avoidance of teaching science altogether, to the teaching of science in a problem solving manner?

These questions formed the initial categories into which data was organized, but in an on-going manner, rather than subsequent to the observation phase. In time, the last question became most significant in terms of formulating assertions and reporting findings.

FINDINGS

My first visit to Jean's classroom provided me with an opportunity to observe her strategy for sharing some of the

ideas gleaned at our workshops with the other teachers in the school. Her class was conducting a mini-science fair which included demonstrations of inquiry skills, problem solving, and available science materials. There were nine stations set up with two or three students at each station demonstrating such topics as convection currents, responses of meal worms to various stimuli, tests used to identify an unknown powder, and the use of pictures to teach the skill of making inferences. Of particular interest to me was the fact that each of these activities was an exact replica either of something I had done with the teachers at my workshops or that Phil had done at one of his weekly in-service sessions. Jean's students knew what they were talking about and had clearly taken on teacher roles; she was free to talk with me and with other visitors to the room.

Most of our conversation centered on the students whom Jean described as the "creme de la creme." Although the learning center is an option now available to all, the majority of those students whose parents select it for them are well above average in intelligence and achievement. In Jean's class, for example, 85 percent of the students scored at or above the 90th percentile on the nationally normed California Standardized Test of Achievement. Additionally, there is a very high degree of parental interest and involvement. Laura,

who told me about her father having taken apart "all the telephones in the house last night because we're studying about sound in science," is typical. These students have participated in the learning center option for almost three years. They have received no grades and competition between them seemed non-existent. There was, instead, an air of intellectual collegial respect and cooperation. Jean encouraged this by using the expertise of particular students to teach others. She communicated tremendous confidence to her students, and even used what others might perceive as mishaps for reinforcement of feelings of self-reliance. Kathy, a girl in her class, accidentally set herself on fire by carelessly leaning over a burning candle; Jean's emphasis afterwards was to praise the quick thinking and action of the boy who pushed Kathy to the ground in order to smother the fire. Also, she let both me and the students know that she would continue to do this activity requiring the use of a candle.

Although one might conclude that Jean's reorientation to teaching science as problem solving is being facilitated by the flexibility of the learning center program, administrative support for both her personally and the program in general, the ability of sixth grade students who have participated in such a program for two years to work independently, tremendous parental support, her own organizational ability and sense of

interdisciplinary possibilities, and a personal love for learning science, very little change is actually occurring. Jean is clearly "doing science" with her students. I would question, however, if any real problem solving is occurring.

Assertion I: A need to see that the kids "get it [the answer] right," eliminates opportunities for problem solving.

Experiencing success and making sure that her students do too is most important to Jean. Introducing a lesson in which the students, working in groups, would build their own telephones, Jean held up a model telephone saying, "I made this yesterday while you were in gym." The students were expected to read the directions for themselves from the textbook and then use the materials provided to replicate Jean's model. During the activity, she circulated among the groups, commenting on the students' efforts.

You've got to <u>make sure</u> the tape touches the metal.

I want you to look at the difference between how I wrapped my wire around the nail and how you did yours. I'm not saying anything, but I want you to look at the difference.

You're not following directions. Be careful -- you're not going to be successful!

One student's telephone was held up as as a "good job" and then later this same student was referred to as "an expert" who could provide assistance to other groups experiencing difficulty in completing the task. Jean spent most of her time with one very successful group which had mastered the basic task and were interested in refining their phone so that its transmission would be more audible.

This theme of "doing things right so as to be successful" was evident again when Jean later related to me a successful experience that her class had during an oceanography field trip. The students had prepared bottles containing a written request for a response from whoever found them; the bottles then were thrown into the ocean with the hopes of learning something more about currents. All the sixth grade classes participated in this activity, but Jean noted,

> Mine was the only class's bottles that didn't come apart. We made them in class.

The message was clear to me that her's had been made <u>right</u>!

Assertion II: Jean has internalized the expectations of administrators that her performance as a teacher will be exemplary. This causes her to exercise a degree of control which inhibits any problem solving efforts on the part of students.

Jean's extraordinarily fine organizational ability results in her finding time and accomplishing more than seems humanly possible. Having a class make their own telephones is generally not something that can be accomplished in one 40 minute period. Jean, however, had cut all the wires to the specified lengths beforehand and also had stripped them so as to insure good contact points for the circuits. Furthermore, the presence of her model telephone could leave no doubt in anyone's mind about exactly what needed to be done in order to be successful.

While saving time doing all these things, Jean also is attempting to keep everything under control. She does not want spontaneous discrepancies to occur; she is only comfortable with the ones she plans. The questionnaire which I asked teachers to complete during our last workshop session together utilized an open-ended statement format. The teachers were asked to respond to as many of the 12 items as they wished in terms of how each item either facilitated or interfered with their personal efforts to teach science in a problem solving manner. Those to which Jean chose <u>not</u> to respond revealed a great deal: "becoming aware of everyday discrepancies," "being/becoming a reflective problem solver myself," and "understanding what is meant by problem solving in science." She <u>did</u> respond to the statements "lack of materials," "lack of

administrative support," and "feelings of insecurity about content" by saying that these were not a problem for her.

Assertion III: There is a dichotomy in Jean's thinking between "science" and "problem solving."

For Jean, problem solving means learning to "apply appropriate skills systematically in ways that demonstrate ... an accurate understanding of science principles" (New York State Education Department, 1984, p. 6). She is providing instruction in problem solving, but it has not occurred to her to use problem solving as a way to learn. After my first visit to her classroom, the mini-science fair observation, she asked me whether I wanted to "see a science lesson or problem solving the next time." Having just seen her students beautifully demonstrate problem solving using activities with which I was familiar, I was shocked at this expression of dichotomy. Subsequent observations and interviews confirmed that they are indeed separate in Jean's mind. She endeavors to weave some of the problem solving activities which she has experienced at workshops into her lessons; the lesson on the telephone drew upon a previously performed activity in which the strength of an electromagnet was first tested and then attempts were made to vary it. Without allowing for spontaneous discrepancies, however, references to such past experiences remain as her

mental connections, a review of "what we learned last time about..." and are in no way an engagement of students in any problem solving of their own (Dewey, 1916).

The textbook contains the science to be taught and Jean is determined that it <u>will</u> be covered. The new syllabus, however, requires only that very broad concepts be taught and does not specifically identify grade levels at which this should occur. I therefore questioned her about why she felt it was necessary to "complete the entire textbook." Her response was, "The district says you have to cover the book." Desiring to probe more deeply into the source of this perception, I arranged to talk with Phil, the science coordinator of the district. His response to my asking if in fact teachers had been told that they must "cover the entire textbook" was enlightening:

> In all elementary schools, once you buy a text, it doesn't matter what the State or the district says [about what is actually required]. It's the nature of elementary teachers to think they must cover the entire book.

At a subsequent curriculum planning meeting, however, arranged for the expressed purpose of deciding "what could be left out" so as to leave more time for problem solving, it was obvious that Phil was not comfortable with eliminating anything. Although Jean pointed out that certain topics were already being covered at a lower grade level, Phil recommended that

they be "covered again as a review". So anxious was he not to exclude "any good ideas" that he even began to look at available supplementary texts and to point out additional things he considered worthwhile.

Conclusion

I do not see Jean as a particularly reflective person and her successful teaching record and the recognition it has received hardly provide any motivation for reflection or change. In one sense I think that she really does not see discrepancies in her daily classroom life; her efficiency overcomes them without any reflection. The concern I have about this is that she may be solving the wrong problems. Using efficient techniques for saving time becomes so important and desirable that nothing is ever let go of for the sake of spontaneous and important problems that happen to occur.

The telephone lesson to which I have alluded followed a unit on sound and was taught during a violent thunderstorm which could hardly be ignored. Students were very interested in knowing how far away the storm was and several of them knew that five seconds between the lightning and thunder represents a distance of one mile. Jean did not immediately squelch their interest in the storm, but she did miss a wonderful opportunity to talk about the speed at which sound travels as compared with

light. More important even than missing such valuable opportunities for allowing students to make connections, she is excluding them from some real opportunities to problem solve. By attempting to foresee every possible obstacle and constantly alerting the students to what they must do in order "to be successful," she does the problem solving for them. The problems, however, are hers and not theirs!

> The pupils have a problem, but it is the problem of meeting the peculiar requirements set by the teacher. Their problems become that of finding out what the teacher wants, what will satisfy the teacher in recitation and examination and outward deportment (Dewey, p. 156).

An Alternative to Success

Jean is not unique among elementary school teachers. Like her, there are many who are "successful" in their teaching. Others strive to be so in the recognized and approved ways that Jean has achieved. However, until teachers begin to experience some dissatisfaction with the "success" they have had, it is unlikely that there will be any change in their approach to teaching science or that any real problem solving will occur.

It seems unfair, though, to expect that classroom teachers be the ones to experience dissatisfaction with the status quo and thus motivate themselves to change. The systems in which

they work are responsible for the superficial level of implementation that is occurring. Jean's building principal and science coordinator who continually praise her because she "makes them look good", the parents who appreciate the high test scores, tangible evidence of their children's success, current emphasis on external effective teaching practices, and the lack of time provided for teachers to reflect on what they're doing all contribute to an inertia which prevents change.

The inertia is bigger than Jean's district, however. All the forces that conspire to put educators on the defensive, that stifle their questions and keep them in their place, remove the one thing that is necessary to effect any real change, that is, discontent. Teacher-proof textbook manuals and kits containing manipulative materials quell teachers' own felt discrepancies and prevent them from personally becoming problem solvers. State Education Departments and Boards of Education that dupe themselves into accepting <u>more</u> science as necessarily <u>better</u> science, and who point with pride at hands-on science like Jean's as indicative of "how well we're doing", discourage any impetus for growth or change feebly endeavoring to take root classrooms. If better is truly what is wanted -- here in the form of problem solving science --

then instructional leaders need first to create a climate in which dissatisfaction can be openly acknowledged and shared.

Reasons cited for the failure of the elementary science curriculum reform movement of the 1960's have been addressed; evidence clearly indicates that educators do not want to repeat the errors of the past. The mentoring system established by the New York State Education Department to provide long-term support and technical assistance for implementation is one example of the renewed determination to have science taught in <u>all</u> elementary classrooms. What seems to have been overlooked in this current drive, however, is any consideration of change as a highly personal experience (Fullan, 1982). Teachers are not empty vessels, passive recipients (Freire, 1981) of change mandates. Their external contexts obviously are made different through arrangements regulating how the business of schooling is done in individual buildings; the forces that have shaped their personal histories give rise to a variety of assumptions about how children learn. These contextual factors necessarily affect the way in which change is both received and executed. The change in question here can not be effected by simple mandate, by telling teachers <u>about</u> problem solving, or even by conducting hands-on problem solving workshops which allow practice time for manipulating materials that then enable teachers to "do it right" back in their own classrooms.

In any change effort it is imperative that those for whom the change is intended be actively involved. According to Dobbert (1982), "Responsibility for the change must be transferred from the innovator to the recipients of the change if it is to be adopted as a useful part of everyday life" (p. 338). I can think of no better way to transfer the responsibility for this change to teachers and to acknowledge the uniqueness of their individual contexts than to encourage them to acknowledge their personally felt discrepancies and accompanying dissatisfactions and then to work together with them toward resolution.

There is much being written about teacher empowerment that suggests it is something that can be <u>given</u> to teachers by those in authority. While sounding beneficent, this mentality still smacks of the malefic generosity (Freire, 1981) which would maintain teachers in positions of subordination by "helping" them to remain dependent on the wisdom of those in authority. Well-intentionned efforts to acknowledge teachers treat them, in many cases, as somehow difficient and in need of being endowed with ability. I submit that pursuing the ideal of an increased sense of efficacy for teachers through emphasis on <u>their</u> problem solving efforts, rather than on their's or their students' external successes, is a far more potent approach to change and improvement.

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